
Bibliography.

---

(19) [Country of Issue] Japan Patent Office (JP)
(12) [Official Gazette Type] Open patent official report (A)
(11) [Publication No.] JP,11-112028,A.
(43) [Date of Publication] April 23, Heisei 11 (1999).
(54) [Title of the Invention] Semiconductor luminescence equipment.
(51) [International Patent Classification (6th Edition)]
H01L 33/00

[FI]
H01L 33/00 A
C
[Request for Examination] ****
[The number of claims] 3.
[Mode of Application] OL.
[Number of Pages] 6.
(21) [Filing Number] Japanese Patent Application No. 9-269576.
(22) [Filing Date] October 2, Heisei 9 (1997).
(71) [Applicant]
[Identification Number] 000005843.
[Name] Matsushita Electronics Industry, Inc.
[Address] 1-1, Saiwai-cho, Takatsuki-shi, Osaka.
(72) [Inventor(s)]
[Name] Maeda Bright person.
[Address] 1-1, Saiwai-cho, Takatsuki-shi, Osaka Inside of Matsushita Electronics Industry, Inc.
(72) [Inventor(s)]
[Name] Obara Kunihiko.
[Address] 1-1, Saiwai-cho, Takatsuki-shi, Osaka Inside of Matsushita Electronics Industry, Inc.
(72) [Inventor(s)]
[Name] Yamaguchi Kazuya.
[Address] 1-1, Saiwai-cho, Takatsuki-shi, Osaka Inside of Matsushita Electronics Industry, Inc.
(72) [Inventor(s)]
[Name] Uchida **.
[Address] 1-1, Saiwai-cho, Takatsuki-shi, Osaka Inside of Matsushita Electronics Industry, Inc.
(74) [Attorney]

[Patent Attorney]
[Name] Takimoto Tomoyuki (besides one person)

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

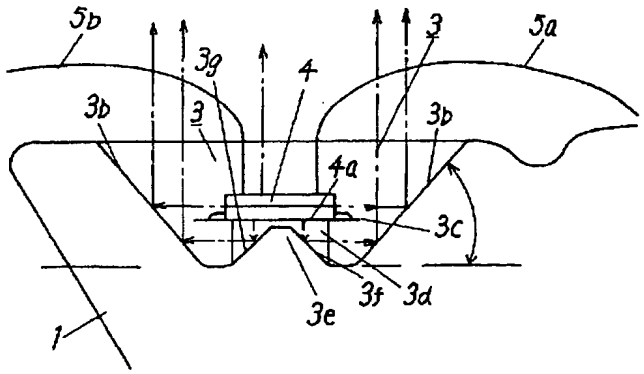
1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

Summary.

---

(57) [Abstract]
[Technical problem] For example, in the light emitting device which carries out the laminating of the gallium-nitride system compound to transparent silicon on sapphire, as the light emitted from a substrate can be effectively collected as an illuminant to an optical drawing side side direction, the whole luminous efficiency is raised.
[Means for Solution] The light emitting device 4 which equipped the main light drawing side side with p lateral-electrode 4b and n lateral-electrode 4c, respectively while carrying out the laminating of the semiconductor layer of p-n junction on transparent crystal substrate 4a, It has the leadframe 1 which makes a light emitting device 4 flow through the mounting 3 in which this light emitting device 4 is carried electrically in preparation for one, and mounting 3 is made to go via the optical path which does not interfere in the light from other fields other than the main light drawing side with a light emitting device 4, and is equipped with the luminescence direction from the main light drawing side, and the reflector structure mostly reflected in the same direction.

[Translation done.]



[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The semiconductor luminescence equipment which is the optical path which does not interfere in the light from other optical drawing sides other than the main light drawing side with a light emitting device at mounting in which it is semiconductor luminescence equipment which is characterized by to provide the following, and which made the field the main light drawing side, and it is formed in a loading flow member and a light emitting device is carried, and comes to have the reflector structure reflect the same direction mostly, with the luminescence direction from the main light drawing side. The light emitting device which equipped with p lateral electrode and n lateral electrode the whole surface which counters with a crystal substrate, respectively while carrying out the laminating of the semiconductor layer of p-n junction on the transparent crystal substrate. It has the loading flow member through which carries this light emitting device and it is made to flow electrically, and is p lateral electrode.

[Claim 2] Mounting is semiconductor luminescence equipment according to claim 1 which comes to form the reflector which the base of a light emitting device is engaged [reflector] in part at least as the shape of a earthenware mortar in which the whole crystal substrate is buried at least of a light emitting device, and it has [reflector] the supporting structure which can carry this, and makes the inner skin reflect mostly the light from other optical drawing sides other than the main light drawing side of a light emitting device in the same direction with the luminescence direction from the main light drawing side further.

[Claim 3] Mounting is semiconductor luminescence equipment according to claim 2 which comes to have the reflective block of the shape of the shape of a truncated cone reflected in the position which confronts each other just under the crystal substrate of a light emitting device towards the direction of a reflector of the inner circumference of mounting of the light which goes to a mounting bottom from a crystal substrate, and a truncated pyramid.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the semiconductor luminescence equipment which raised luminescence brightness by starting the gallium-nitride system compound semiconductor luminescence equipment used for optical devices, such as blue light emitting diode, especially reflecting efficiently luminescence to a retrose from an optical drawing side.
[0002]
[Description of the Prior Art] Gallium-nitride system compound semiconductors, such as GaN, GaAlN, InGaN, and InAlGaN, come to be used abundantly as a semiconductor material for a visible photoluminescence device or elevated-temperature operation electron devices, and expansion in the field of blue light emitting diode is progressing.
[0003] Generally in manufacture of the semiconductor of this gallium-nitride system compound, insulating sapphire is used as a crystal substrate for growing up a semiconductor film in the front face. In the case where an insulating crystal substrate like this sapphire is used, since an electrode cannot be taken out from a crystal substrate side, the electrode of p and n which are prepared in a semiconductor layer will be formed in the whole surface side of a crystal substrate.
[0004] Drawing 6 is the schematic diagram showing the loading structure of the light emitting device to the conventional mounting. It carried on mounting 52a which formed the insulating substrate 51a in the upper limit of a leadframe 52, and pasted up with a paste 53, and the light emitting device 51 has connected 51c to the leadframe 55 of another side which is making a leadframe 52 and this, and the pair with Wires 54a and 54b the 51b and n side very much the p side formed in the upper limit of a light emitting device 51, respectively. And the whole circumference of mounting 52a including a light emitting device 51 is closed by the epoxy resin 56.
[0005] With the Light Emitting Diode lamp containing such a light emitting device 51, upward luminescence is obtained considering the upper surface of p type layer which occupies the field which contains 51b very much the p side as an optical drawing side by making the p-n junction region of the semiconductor film of the gallium-nitride system compound of a light emitting device 51 into a luminous layer. And in the case where substrate 51a considers as transparent sapphire, only from the optical drawing side of the upper-limit side of a light emitting device 1, the light from a luminous layer will be outputted, even if it turns to the bottom from this substrate 51a.
[0006]
[Problem(s) to be Solved by the Invention] Since it is soon carried on mounting 52a, if the front face of mounting 52a is made into the shape of a mirror plane, substrate 51a reflects the light from substrate 51a, and can add this reflected light to luminescence from an optical drawing side.
[0007] However, luminescence which goes downward from substrate 51a will repeat reflection by mounting 52a, the re-incidence to substrate 51a after this reflection, and the incidence to the luminous layer of a p-n junction region, and will emit light from an optical drawing side. For this reason, the light which came out of substrate 51a is decreased in process of such reflection and

re-incidence, and when emitting light finally from an optical drawing side, the decline in an external quantum efficiency is not escaped. Therefore, conventionally like illustration, with structure, luminescence from the substrate 51a side cannot fully be collected, but there is a limitation also in improvement in luminescence brightness.

[0008] There are some which were indicated by JP,7-86640,A as luminescence equipment which carried in the leadframe the luminescence chip which, on the other hand, carried out the laminating of the semiconductor of the gallium-nitride system compound which has p-n junction on silicon on sapphire.

[0009] This makes transparent the adhesives for fixation in mounting 52a of the light emitting device 51 shown in drawing 6 , and as stated previously, it is made to reflect downward luminescence for the upper surface of mounting 52a as a mirror plane. And it is indicating urging heat transfer from a light emitting device 51 to a leadframe 52 side, and losing decline in the luminous efficiency of a light emitting device 51 by this by mixing an insulating filler with high thermal conductivity in adhesives.

[0010] However, although it is possible to prevent the temperature rise of a light emitting device using the adhesives containing such a filler, about the light taken out from substrate 51a at the mounting 52a side as the example of drawing 6 showed, attenuation of the quantity of light by reflection or re-incidence is not avoided, but there is a limitation in improvement in luminescence brightness similarly. And since it can contribute more greatly than improvement in the luminous efficiency by promotion of heat dissipation of the way of the recovery to the optical drawing side side of luminescence to the mounting 52a side from substrate 51a of a light emitting device 51, an extensive improvement of luminescence brightness is not expectable only by mixing a thermally conductive high filler in adhesives.

[0011] Thus, with the conventional luminescence equipment which emits light even if a substrate is transparent and it turns to the loading side side, there is a problem that the light which escapes from a substrate side is effectively unrecoverable as an illuminant by the side of an optical drawing side.

[0012] The technical problem which should be solved in this invention is to raise the whole luminous efficiency, as the light emitted from a substrate in the light emitting device which carries out the laminating for example, of the gallium-nitride system compound to transparent silicon on sapphire can be effectively collected as an illuminant to an optical drawing side side direction.

[0013]

[Means for Solving the Problem] The light emitting device which equipped with p lateral electrode and n lateral electrode the whole surface which counters with a crystal substrate while this invention carries out the laminating of the semiconductor layer of p-n junction on a transparent crystal substrate, respectively, It has the loading flow member through which carries this light emitting device and it is made to flow electrically. It is semiconductor luminescence equipment which made the field in which p lateral electrode was prepared the main light drawing side. It is the optical path which does not interfere in the light from other optical drawing sides other than the main light drawing side with a light emitting device, and it has the luminescence direction from the main light drawing side, and the reflector structure of reflecting the same direction mostly, and is characterized by the bird clapper at mounting in which it is formed in a loading flow member and a light emitting device is carried.

[0014] With such composition, it can be made to reflect in the luminescence direction from the main light drawing side side, while there has been no light by which luminescence brightness is emitted to a mounting side from fields other than the greatest main light drawing side into a light

emitting device by the,reflector structure prepared in this mounting reentry putting, and few luminescence of attenuation of the whole quantity of light is obtained.
[0015] In addition, in this invention, the loading flow member through which carries a light emitting device and it is made to flow electrically is a leadframe as the term of the form of implementation of invention shows, in addition also let them be various kinds of casts arranged as another object above a printed circuit board or a printed circuit board.
[0016]
[Embodiments of the Invention] The light emitting device which equipped with p lateral electrode and n lateral electrode the whole surface which counters with a crystal substrate while invention according to claim 1 carries out the laminating of the semiconductor layer of p–n junction on a transparent crystal substrate, respectively, It has the loading flow member through which carries this light emitting device and it is made to flow electrically. It is semiconductor luminescence equipment which made the field in which p lateral electrode was prepared the main light drawing side. To mounting in which it is formed in a loading flow member and a light emitting device is carried, the light from other optical drawing sides other than the main light drawing side It is a light emitting device and the optical path in which it does not interfere, and is the thing which comes to have the luminescence direction from the main light drawing side, and the reflector structure mostly reflected in the same direction. It has operation of reflecting mostly in the same direction the light emitted to a mounting side, the fields, for example, the crystal substrate, other than the main light drawing side, with the luminescence direction from the main light drawing side side according to the reflector structure prepared in this mounting while there has been nothing into a light emitting device reentry putting.
[0017] The base of a light emitting device is engaged in part at least as the shape of a earthenware mortar in which the whole crystal substrate is buried at least of a light emitting device, and, as for invention according to claim 2, mounting has the supporting structure which can carry this. Furthermore, it is the thing which comes to form the reflector which makes the inner skin reflect mostly the light from other optical drawing sides other than the main light drawing side of a light emitting device in the same direction with the luminescence direction from the main light drawing side. It has the operation of making it reflect so that the optical path of the reflected light may not interfere with a light emitting device as a reflector of light using the inner skin of mounting.
[0018] Invention according to claim 3 mounting in the position which confronts each other just under the crystal substrate of a light emitting device It is the thing which comes to have the reflective block of the shape of the shape of a truncated cone reflected towards the direction of a reflector of the inner circumference of mounting of the light which goes to a mounting bottom from a crystal substrate, and a truncated pyramid. It has the operation of bypassing a light–emitting–device side, carrying out light which leaked from the crystal substrate downward like a rectangular prism from the inner skin of mounting, and making it reflect in the same direction mostly with the luminescence direction from the main light drawing side.
[0019] Below, the example of the form of operation of this invention is explained, referring to a drawing. The plan of drawing 1 drawing of longitudinal section [drawing 2 / drawing of longitudinal section of the important section of the Light Emitting Diode lamp equipped with the Light Emitting Diode chip with which drawing 1 is formed of GaAs GaAlAs, etc. in a form of 1 operation of this invention as a light emitting device, and] / according / drawing 3 / to the A–A line view of drawing 1 , and drawing 4 are the expanded sectional views of an important section showing the nest of the light emitting device to mounting, and the optical path of the reflected light.

[0020] In drawing, while having as a loading flow member of the light emitting device in the form of this operation of the leadframes 1 and 2 of the couple by which the upper-limit section is closed by the epoxy resin, being able to dent mostly the mounting 3 for carrying a light emitting device 4 in the upper limit of one leadframe 1 in the shape of a earthenware mortar and forming, the whole inner skin is made into the shape of a mirror plane. Like what was stated in the conventional example, a light emitting device 4 forms p lateral-electrode 4b and n lateral-electrode 4c in a upper-limit side while preparing crystal substrate 4a using transparent sapphire in a soffit side, and it is carrying out wirebonding of these each to leadframes 1 and 2 with Wires 5a and 5b.

[0021] A light emitting device 4 emits light towards the side and lower part also from crystal substrate 4a located in the luminous layer bottom while making the field which is the upper surface and contains p lateral-electrode 4b like the thing in which the semiconductor cascade screen of the conventional gallium-nitride system compound was formed the main light drawing side. And in the conventional example, although reflection was used from mounting 3 to luminescence from such crystal substrate 4a, from crystal substrate 4a to the main light drawing side of a upper limit is passed, and it collected as the reflected light. On the other hand, in this invention, luminescence from crystal substrate 4a was considered as the composition of the mounting 3 which is soon reflected from mounting 3, without returning to a light-emitting-device 4 side from crystal substrate 4a.

[0022] That is, as mounting 3 is shown in drawing 2 , it is formed in the shape of [to which a flat-surface configuration carries out eccentricity of this, and arranges it to the square light emitting device 4 mostly / like] a earthenware mortar, the eccentric direction of a light emitting device 4 and the sense by the side of reverse are set to gentle slope 3a of about 40-degree inclination, and the methods of three except this are set to common reflector 3b of about 60-degree inclination. Maintenance seat 3c which made the trapezoidal shape mostly the flat-surface configuration for carrying a light emitting device 4 is formed in each of gentle slope 3a and common reflector 3b of the position which counters this, and cavity 3d for being able to dent downward under this maintenance seat 3c, and giving a crevice between the bases of a light emitting device 4 is prepared in it. Among maintenance seat 3c, as shown in drawing 1 , reflective block 3e made into the longitudinal-section configuration of a 2 equilateral trapezoidal shape is formed, and a this cavity 3d bottom makes the 2nd page of this block 3e the light-receiving reflectors 3f and 3g of the light which goes downward from a light emitting device 4 while it is in agreement with the base of the earthenware mortar-like mounting 3. As long as an outline is the thing of a truncated cone or a truncated pyramid, any are [that what is necessary is just what can form the reflector of a trapezoidal shape like illustration] sufficient as block 3e.

[0023] In addition, although the interior of mounting 3 is formed in the example of illustration as an inclined plane of gentle slope 3a and common reflector 3b where inclination differs, respectively, it is undoubted that it is good also considering all the methods of four as common reflector 3b of the same inclination. Thus, preparing gentle slope 3a makes it one purpose to place luminescence from common reflector 3b of the method of three upside down, and to make it be easy to be visible, when including in high positions, such as the outdoors, at a display panel as what rotated 90 degrees of leadframes 1 counterclockwise in drawing 3 .

[0024] A light emitting device 4 is pasted up on this maintenance seat 3c with the transparent paste 6 while it carries a both-sides portion on maintenance seat 3c, as shown in drawing 1 .

[0025] In the above composition, when energized to a light emitting device 4, the light from the luminous layer of a p-n junction region leaks and comes from crystal substrate 4a using transparent sapphire also to down and the side at the same time it is emitted from the main light

drawing side of the upper surface of p type layer, as stated also in advance.
[0026] Luminescence to the side from a light emitting device 4 escapes from the transparent paste 6, progresses in gentle slope 3a of mounting 3, and the direction of common reflector 3b, and is mostly reflected in the same direction by these gentle slope 3a and common inclined plane 3b with the luminescence direction from the main light drawing side of a light emitting device 4.
[0027] Moreover, the light which goes downward from crystal substrate 4a changes an optical path in the direction of common reflector 3b of the couple which has countered these, after being reached and reflected in the light-receiving reflectors 3f and 3g of reflective block 3e located just under a light emitting device 4. And like the light from the side, it is reflected by this common reflector 3b, and progresses in the almost same direction as the luminescence direction from the main light drawing side of a light emitting device 4.
[0028] Thus, the light which leaks from crystal substrate 4a of a light emitting device 4 to the side and a lower part is altogether reflected from gentle slope 3a of mounting 3, and common reflector 3b, not containing crystal substrate 4a in an optical path. Therefore, in the case where light is made to emit from the main light drawing side after reflecting the light which leaked and came out of crystal substrate 4a and carrying out incidence to this crystal substrate 4a, as the conventional example showed, the direct reflected light from gentle slope 3a and common reflector 3b is obtained by relations, such as permeability of light, to the quantity of light which finally emits light declining. In addition to luminescence from the main light drawing side, the light emitted from transparent crystal substrate 4a can be added by this, and luminous efficiency can be raised sharply.
[0029] (a) of drawing 5 and (b) are the schematic diagrams of an important section showing a respectively different example. (a) of this drawing prepares only reflective block 3e of the trapezoidal-shape cross section which has the upper-limit side of the grade that this can be carried, in response to the pars basilaris ossis occipitalis of a light emitting device 4 in the pars basilaris ossis occipitalis of mounting 3, puts crystal substrate 4a of a light emitting device 4 on this reflective block 3e, and pastes it up with the transparent paste 6.
[0030] Also in this example, it is reflected from gentle slope 3a and common reflector 3b which were formed in mounting 3, and the light which leaks and comes out of crystal substrate 4a of a light emitting device 4 joins luminescence from the main light drawing side. Moreover, since the paste 6 is transparent, and the light which leaks and comes from the base of crystal substrate 4a escapes from this and reaches the light-receiving reflectors 3f and 3g of reflective block 3e, it is similarly reflected from common reflector 3b, and it joins the light from the main light drawing side, and emits light.
[0031] Moreover, (b) of this drawing puts transparent glass 7 on reflective block 3e, carries substrate 4a of a light emitting device 4 in the upper surface, and joins it to one with transparent adhesives etc.
[0032] Also in this example, since the light which leaks and comes from the base of crystal substrate 4a escapes from transparent glass 7 and reaches the light-receiving reflectors 3f and 3g of reflective block 3e, it is similarly reflected from common reflector 3b, and it joins the light from the main light drawing side, and emits light.
[0033]
[Effect of the Invention] compared with structure, attenuation of the whole quantity of light is suppressed conventionally which are collected from the main light drawing side after the re-incidence to a light emitting device, and since it can be made to reflect in the luminescence direction from the main light drawing side side while there has been nothing into a light emitting

device reentry putting, luminous efficiency is markedly alike and improves in invention of a claim 1 according to the reflector structure which prepared the light emitted to a mounting side from a crystal substrate in this mounting

[0034] In invention of a claim 2, since it is made to reflect so that the optical path of the reflected light may not interfere with a light emitting device as a reflector of light using the inner skin of mounting, complicated reflector structure is not needed that what is necessary is just to design the configuration of mounting so that it may become the reflective direction of the same direction from the main light drawing side about the light from a crystal substrate, but an assembly also becomes easy.

[0035] In invention of a claim 3, since it is made to reflect in the luminescence direction from the main light drawing side only by two reflection with a reflective block and the reflector of the inner skin of mounting, the light which leaked from the crystal substrate downward can collect from a crystal substrate efficiently the light which goes downward, and its luminous efficiency improves further.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] Drawing of longitudinal section showing the important section of the luminescence equipment using the gallium-nitride system compound semiconductor light emitting device by the gestalt of 1 operation of this invention

[Drawing 2] The plan of drawing 1

[Drawing 3] Drawing of longitudinal section by the A-A line view of drawing 1

[Drawing 4] The enlarged vertical longitudinal sectional view of an important section showing the nest of the light emitting device to mounting, and the optical path of the reflected light

[Drawing 5] It is drawing of longitudinal section of an important section with which it is the example which carries and incorporates a light emitting device after that mounting blocks [reflective], and drawing of longitudinal section (b) of an important section to which (a) joined the light emitting device with a transparent paste carried the light emitting device on transparent glass.

[Drawing 6] The schematic diagram showing the conventional Light Emitting Diode lamp

[Description of Notations]

1 Leadframe

2 Leadframe

3 Mounting
3a Gentle slope
3b Common reflector
3c Maintenance seat
3d Cavity
3e Reflective block
3f, 3g Light-receiving reflector
4 Light Emitting Device
4a Crystal substrate
4b p lateral electrode
4c n lateral electrode
5a, 5b Wire
6 Paste
7 Transparent Glass

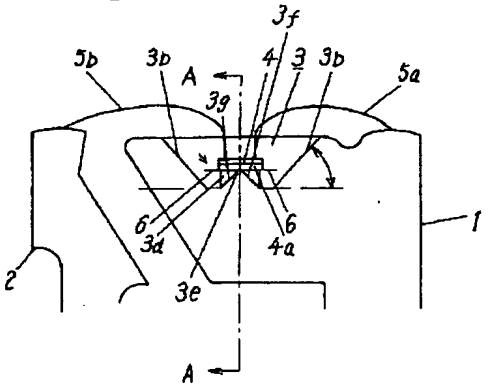
[Translation done.]

* NOTICES *

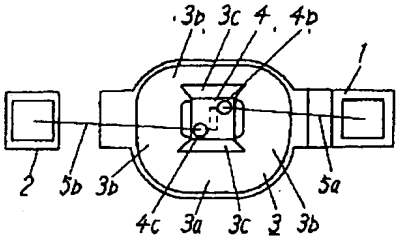
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

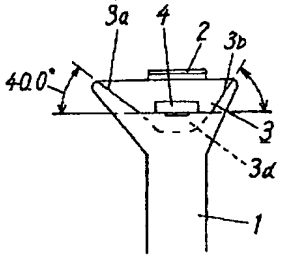
[Drawing 1]



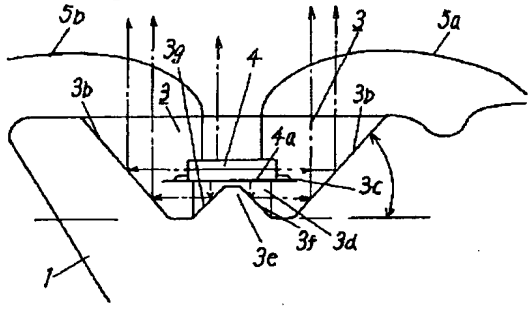
[Drawing 2]



[Drawing 3]

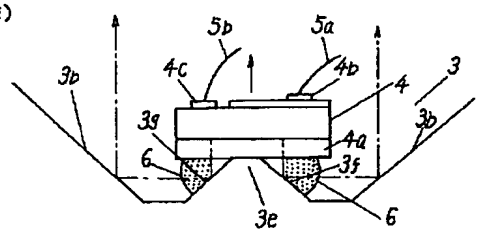


[Drawing 4]

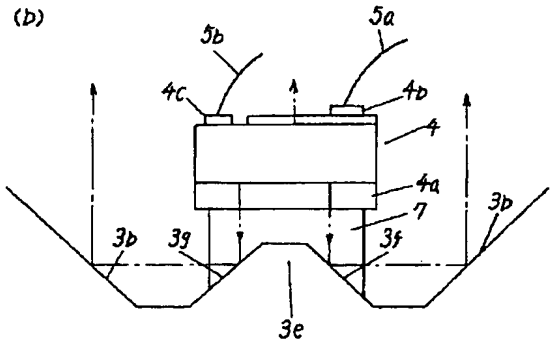


[Drawing 5]

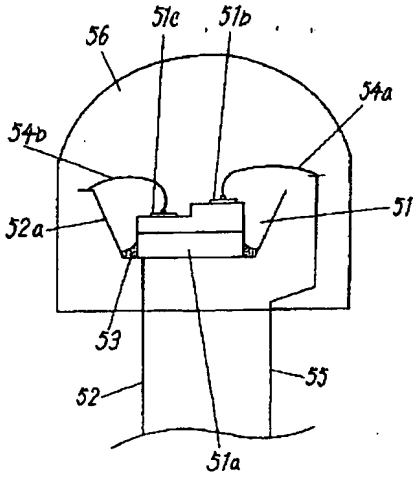
(a)



(b)



[Drawing 6]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平11－112028

(43)公開日　平成11年(1999)４月23日

(51)Int.Cl.[6]	識別記号	ＦＩ	
Ｈ０１Ｌ　33/00		Ｈ０１Ｌ　33/00	Ａ Ｃ

審査請求　有　　請求項の数３　ＯＬ　（全　６　頁）

(21)出願番号　特願平9－269576

(22)出願日　平成９年(1997)10月２日

(71)出願人　000005843
松下電子工業株式会社
大阪府高槻市幸町１番１号

(72)発明者　前田　俊秀
大阪府高槻市幸町１番１号　松下電子工業株式会社内

(72)発明者　小原　邦彦
大阪府高槻市幸町１番１号　松下電子工業株式会社内

(72)発明者　山口　和也
大阪府高槻市幸町１番１号　松下電子工業株式会社内

(74)代理人　弁理士　滝本　智之　（外１名）

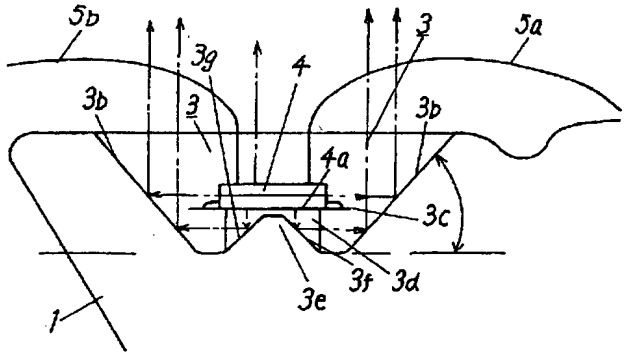
最終頁に続く

(54)【発明の名称】　半導体発光装置

(57)【要約】

【課題】　たとえば窒化ガリウム系化合物を透明のサファイア基板に積層する発光素子において、基板から放出される光を光取出し面側方向への発光分として有効に回収できるようにして全体の発光効率を向上させる。

【解決手段】　透明の結晶基板４ａの上にｐ－ｎ接合の半導体層を積層するとともに主光取出し面側にｐ側電極４ｂ及びｎ側電極４ｃをそれぞれ備えた発光素子４と、この発光素子４を搭載するマウント３を一体に備えて発光素子４に電気的に導通させるリードフレーム１とを備え、マウント３には、主光取出し面以外の他の面からの光を、発光素子４と干渉しない光路を経由させて主光取出し面からの発光方向とほぼ同じ向きに反射させる反射面構造を備える。



【特許請求の範囲】
【請求項１】　透明の結晶基板の上にｐ－ｎ接合の半導体層を積層するとともに結晶基板と対向する一面にｐ側電極及びｎ側電極をそれぞれ備えた発光素子と、この発光素子を搭載して電気的に導通させる搭載導通部材とを備え、ｐ側電極を設けた面を主光取出し面とした半導体発光装置であって、搭載導通部材に形成されて発光素子を搭載するマウントに、主光取出し面以外のほかの光取出し面からの光を、発光素子と干渉しない光路であって主光取出し面からの発光方向とほぼ同じ向きに反射させる反射面構造を備えてなる半導体発光装置。
【請求項２】　マウントは、発光素子の少なくとも結晶基板の全体が埋没するすり鉢状として発光素子の底面の少なくとも一部に係合してこれを搭載可能な支持構造を持ち、更にその内周面には、発光素子の主光取出し面以外のほかの光取出し面からの光を主光取出し面からの発光方向とほぼ同一方向に反射させる反射面を形成してなる請求項１記載の半導体発光装置。
【請求項３】　マウントは、発光素子の結晶基板の真下に対峙する位置に、結晶基板からマウント底部に向かう光をマウントの内周の反射面方向に向けて反射する円錐台状または角錐台状の反射ブロックを備えてなる請求項２記載の半導体発光装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、青色発光ダイオード等の光デバイスに利用される窒化ガリウム系化合物半導体発光装置に係り、特に光取出し面から逆向きへの発光も効率良く反射させることにより発光輝度を向上させた半導体発光装置に関する。
【０００２】
【従来の技術】ＧａＮ，ＧａＡｌＮ，ＩｎＧａＮ及びＩｎＡｌＧａＮ等の窒化ガリウム系化合物半導体は、可視光発光デバイスや高温動作電子デバイス用の半導体材料として多用されるようになり、青色発光ダイオードの分野での展開が進んでいる。
【０００３】この窒化ガリウム系化合物の半導体の製造では、その表面において半導体膜を成長させるための結晶基板として、一般的には絶縁性のサファイアが利用される。このサファイアのような絶縁性の結晶基板を用いる場合では、結晶基板側から電極を出すことができないので、半導体層に設けるｐ，ｎの電極は結晶基板の一面側に形成されることになる。
【０００４】図６は従来のマウントに対する発光素子の搭載構造を示す概略図である。発光素子５１は、その絶縁性の基板５１ａをリードフレーム５２の上端に形成したマウント５２ａの上に搭載してペースト５３によって接着され、発光素子５１の上端にそれぞれ形成したｐ側極５１ｂ及びｎ側極５１ｃをワイヤ５４ａ，５４ｂによってリードフレーム５２及びこれと対をなしている他方のリードフレーム５５に接続している。そして、発光素子５１を含めてマウント５２ａ周りの全体がエポキシ樹脂５６によって封止されている。
【０００５】このような発光素子５１を含むＬＥＤランプでは、発光素子５１の窒化ガリウム系化合物の半導体膜のｐ－ｎ接合域を発光層として、ｐ側極５１ｂを含む領域を占めるｐ型層の上面を光取出し面として上向きの発光が得られる。そして、基板５１ａが透明なサファイアとする場合では、発光層からの光は発光素子１の上端面の光取出し面からだけでなく、この基板５１ａから下側に向けても出力されることになる。
【０００６】
【発明が解決しようとする課題】基板５１ａはマウント５２ａの上に直に搭載されているので、マウント５２ａの表面を鏡面状としておけば、基板５１ａからの光を反射して光取出し面からの発光にこの反射光を加えることができる。
【０００７】ところが、基板５１ａから下へ向かう発光は、マウント５２ａによる反射，この反射後の基板５１ａへの再入射，ｐ－ｎ接合域の発光層への入射を繰り返して光取出し面から発光されることになる。このため、基板５１ａから出た光は、このような反射及び再入射の過程で減衰してしまい、光取出し面から最終的に発光されるときに外部量子効率の低下は免れない。したがって、図示のような従来構造では、基板５１ａ側からの発光を十分に回収できず、発光輝度の向上にも限界がある。
【０００８】一方、サファイア基板上にｐ－ｎ接合を持つ窒化ガリウム系化合物の半導体を積層した発光チップをリードフレームに搭載した発光装置として、たとえば特開平７－８６６４０号公報に記載されたものがある。
【０００９】これは、図６に示した発光素子５１のマウント５２ａへの固定のための接着剤を透明として、先に述べたようにマウント５２ａの上面を鏡面として下向きの発光を反射させるようにしたものである。そして、接着剤には熱伝導率の高い絶縁性のフィラーを混入しておくことで、発光素子５１からリードフレーム５２側への熱伝達を促すようにし、これによって発光素子５１の発光効率の低下をなくすことを開示している。
【００１０】しかしながら、このようなフィラーを含む接着剤を用いて発光素子の温度上昇を防ぐことは可能であるものの、図６の例で示したように基板５１ａからマウント５２ａ側に取り出される光については、反射や再入射による光量の減衰は避けられず、発光輝度の向上には同様に限界がある。そして、基板５１ａからマウント５２ａ側への発光の光取出し面側への回収のほうが、発光素子５１の放熱の促進による発光効率の向上よりも大きく貢献できることから、接着剤に熱伝導性の高いフィラーを混入するだけでは発光輝度の大幅な改善は期待できない。

【００１１】このように、基板が透明であってその搭載面側に向けても発光される従来の発光装置では、基板側から抜ける光を光取出し面側の発光分として有効に回収できないという問題がある。

【００１２】本発明において解決すべき課題は、たとえば窒化ガリウム系化合物を透明のサファイア基板に積層する発光素子において基板から放出される光を光取出し面側方向への発光分として有効に回収できるようにして全体の発光効率を向上させることにある。

【００１３】

【課題を解決するための手段】本発明は、透明の結晶基板の上にｐ－ｎ接合の半導体層を積層するとともに結晶基板と対向する一面にｐ側電極及びｎ側電極をそれぞれ備えた発光素子と、この発光素子を搭載して電気的に導通させる搭載導通部材とを備え、ｐ側電極を設けた面を主光取出し面とした半導体発光装置であって、搭載導通部材に形成されて発光素子を搭載するマウントに、主光取出し面以外のほかの光取出し面からの光を、発光素子と干渉しない光路であって主光取出し面からの発光方向とほぼ同じ向きに反射させる反射面構造を備えてなることを特徴とする。

【００１４】このような構成であれば、発光輝度が最大の主光取出し面以外の面からマウント側に放出される光は、このマウントに設けた反射面構造によって発光素子の中に再入射しないまま主光取出し面側からの発光方向に反射させることができ、全体光量の減衰の少ない発光が得られる。

【００１５】なお、本発明においては、発光素子を搭載して電気的に導通させる搭載導通部材は、発明の実施の形態の項で示すようにリードフレームであり、この他にもプリント基板またはプリント基板の上方に別体として配置する各種の成型品とすることもできる。

【００１６】

【発明の実施の形態】請求項１に記載の発明は、透明の結晶基板の上にｐ－ｎ接合の半導体層を積層するとともに結晶基板と対向する一面にｐ側電極及びｎ側電極をそれぞれ備えた発光素子と、この発光素子を搭載して電気的に導通させる搭載導通部材とを備え、ｐ側電極を設けた面を主光取出し面とした半導体発光装置であって、搭載導通部材に形成されて発光素子を搭載するマウントに、主光取出し面以外のほかの光取出し面からの光を、発光素子と干渉しない光路であって主光取出し面からの発光方向とほぼ同じ向きに反射させる反射面構造を備えてなるものであり、主光取出し面以外の面たとえば結晶基板からマウント側に放出される光を、このマウントに設けた反射面構造によって発光素子の中に再入射しないまま主光取出し面側からの発光方向とほぼ同じ向きに反射させるという作用を有する。

【００１７】請求項２に記載の発明は、マウントは、発光素子の少なくとも結晶基板の全体が埋没するすり鉢状として発光素子の底面の少なくとも一部に係合してこれを搭載可能な支持構造を持ち、更にその内周面には、発光素子の主光取出し面以外のほかの光取出し面からの光を主光取出し面からの発光方向とほぼ同一方向に反射させる反射面を形成してなるものであり、マウントの内周面を光の反射面として利用して反射光の光路が発光素子と干渉しないように反射させるという作用を有する。

【００１８】請求項３に記載の発明は、マウントは、発光素子の結晶基板の真下に対峙する位置に、結晶基板からマウント底部に向かう光をマウントの内周の反射面方向に向けて反射する円錐台状または角錐台状の反射ブロックを備えてなるものであり、結晶基板から下に漏れた光を発光素子側を迂回してマウントの内周面から直角プリズムのようにして主光取出し面からの発光方向とほぼ同じ向きに反射させるという作用を有する。

【００１９】以下に、本発明の実施の形態の具体例を図面を参照しながら説明する。図１は本発明の一実施の形態におけるＧａＡｓやＧａＡｌＡｓ等によって形成されるＬＥＤチップを発光素子として備えるＬＥＤランプの要部の縦断面図、図２は図１の平面図、及び図３は図１のＡ－Ａ線矢視による縦断面図、図４はマウントへの発光素子の組込み及び反射光の光路を示す要部の拡大断面図である。

【００２０】図において、その上端部がエポキシ樹脂によって封止される一対のリードフレーム１，２を本実施の形態における発光素子の搭載導通部材として備え、一方のリードフレーム１の上端には発光素子４を搭載するためのマウント３をほぼすり鉢状に凹ませて形成するとともにその内周面の全体を鏡面状としている。発光素子４は、従来例で述べたものと同様に、下端側に透明のサファイアを用いた結晶基板４ａを設けるとともに上端側にｐ側電極４ｂ及びｎ側電極４ｃを形成し、これらのそれぞれをワイヤ５ａ，５ｂによってリードフレーム１，２にワイヤボンディングしている。

【００２１】発光素子４は、従来の窒化ガリウム系化合物の半導体積層膜を形成したものと同様に、その上面であってｐ側電極４ｂを含む面を主光取出し面とするとともに、発光層の下側に位置している結晶基板４ａからもその側方及び下方に向けて発光する。そして、従来例では、このような結晶基板４ａからの発光に対しては、マウント３から反射を利用するものの、結晶基板４ａから上端の主光取出し面までを通過させて反射光として回収するというものであった。これに対し、本発明では、結晶基板４ａからの発光を結晶基板４ａから発光素子４側に戻さずに、マウント３から直に反射させるようなマウント３の構成とした。

【００２２】すなわち、マウント３は図２に示すように、平面形状がほぼ正方形の発光素子４に対してこれを偏心させて配置するようなすり鉢状に形成され、発光素子４の偏心方向と逆側の向きを４０°程度の勾配の緩傾

斜面３ａとし、これを除く３方を６０°程度の勾配の常用反射面３ｂとしている。緩傾斜面３ａとこれに対向する位置の常用反射面３ｂのそれぞれには、発光素子４を載せるための平面形状をほぼ台形状とした保持座３ｃを形成し、この保持座３ｃの下方には下に凹ませて発光素子４の底面との間に隙間を持たせるためのキャビティ３ｄを設ける。このキャビティ３ｄの底はすり鉢状のマウント３の底面に一致するとともに、保持座３ｃどうしの間には、図１に示すように２等辺の台形状の縦断面形状とした反射ブロック３ｅが形成され、このブロック３ｅの２面を発光素子４から下に向かう光の受光反射面３ｆ，３ｇとしている。ブロック３ｅは図示のような台形状の反射面を形成できるものであればよく、外郭が円錐台や角錐台のものであればいずれでもよい。

【００２３】なお、図示の例では、マウント３の内部を緩傾斜面３ａと常用反射面３ｂのそれぞれ勾配が異なる傾斜面として形成しているが、４方の全てを同じ勾配の常用反射面３ｂとしてもよいことは無論である。このように緩傾斜面３ａを設けるのは、たとえば図３においてリードフレーム１を反時計方向に９０°回転させたものとして屋外等の高い位置に表示パネルに組み込むとき、３方の常用反射面３ｂからの発光を下向きにして見えやすいようにすることを一つの目的としたものである。

【００２４】発光素子４は図１に示すように、保持座３ｃの上に両辺部分を載せるとともに透明のペースト６によってこの保持座３ｃに接着される。

【００２５】以上の構成において、発光素子４へ通電されるときにはｐ－ｎ接合域の発光層からの光は、先にも述べたようにｐ型層の上面の主光取出し面から放出されると同時に透明のサファイアを利用した結晶基板４ａから下方向及び側方へも漏れ出る。

【００２６】発光素子４から側方への発光は、透明のペースト６を抜けてマウント３の緩傾斜面３ａ及び常用反射面３ｂ方向に進み、これらの緩傾斜面３ａ及び常用傾斜面３ｂによって発光素子４の主光取出し面からの発光方向とほぼ同じ向きに反射される。

【００２７】また、結晶基板４ａから下に向かう光は、発光素子４の真下に位置している反射ブロック３ｅの受光反射面３ｆ，３ｇに達して反射された後、これらに対向している一対の常用反射面３ｂ方向に光路を変える。そして、側方からの光と同様に、この常用反射面３ｂで反射されて発光素子４の主光取出し面からの発光方向とほぼ同じ方向に進む。

【００２８】このように、発光素子４の結晶基板４ａから側方及び下方に漏れる光は、結晶基板４ａを光路中に含まないままで、マウント３の緩傾斜面３ａ及び常用反射面３ｂから全て反射される。したがって、従来例で示したように、結晶基板４ａから漏れ出た光を反射させた後にこの結晶基板４ａに入射させた後に主光取出し面から発光させる場合では、光の透過率等の関係によって最終的に発光される光量が減衰してしまうのに対し、緩傾斜面３ａ及び常用反射面３ｂからの直接的な反射光が得られる。これにより、主光取出し面からの発光に加えて、透明の結晶基板４ａから放たれる光を加えることができ、発光効率を大幅に向上させることができる。

【００２９】図５の（ａ）及び（ｂ）はそれぞれ別の例を示す要部の概略図である。同図の（ａ）はマウント３の底部に発光素子４の底部を受けてこれを搭載可能な程度の上端面を持つ台形状断面の反射ブロック３ｅだけを設け、この反射ブロック３ｅに発光素子４の結晶基板４ａを載せて透明のペースト６によって接着したものである。

【００３０】この例においても、発光素子４の結晶基板４ａから漏れ出る光はマウント３に形成された緩傾斜面３ａ及び常用反射面３ｂから反射されて主光取出し面からの発光に加わる。また、結晶基板４ａの底面から漏れ出る光は、ペースト６が透明であることからこれを抜けて反射ブロック３ｅの受光反射面３ｆ，３ｇに達するので、同様に常用反射面３ｂから反射され、主光取出し面からの光と合流して発光される。

【００３１】また、同図の（ｂ）は、反射ブロック３ｅに透明ガラス７を被せてその上面に発光素子４の基板４ａを搭載して透明接着剤等によって一体に接合したものである。

【００３２】この例においても、結晶基板４ａの底面から漏れ出る光は、透明ガラス７を抜けて反射ブロック３ｅの受光反射面３ｆ，３ｇに達するので、同様に常用反射面３ｂから反射され、主光取出し面からの光と合流して発光される。

【００３３】

【発明の効果】請求項１の発明では、結晶基板からマウント側に放出される光を、このマウントに設けた反射面構造によって発光素子の中に再入射しないまま主光取出し面側からの発光方向に反射させることができるので、発光素子への再入射後に主光取出し面から回収する従来構造に比べると、全体光量の減衰が抑えられ、発光効率が格段に向上する。

【００３４】請求項２の発明では、マウントの内周面を光の反射面として利用して反射光の光路が発光素子と干渉しないように反射させるので、結晶基板からの光を主光取出し面から同じ向きの反射方向となるようにマウントの形状を設計するだけでよく、複雑な反射面構造を必要とせず、アセンブリーも簡単になる。

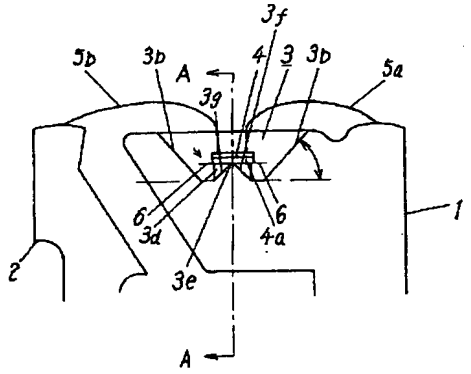
【００３５】請求項３の発明では、結晶基板から下に漏れた光は反射ブロックとマウントの内周面の反射面との２回の反射だけで主光取出し面からの発光方向に反射させるので、結晶基板から下に向かう光を効率よく回収することができ、発光効率が更に向上する。

【図面の簡単な説明】

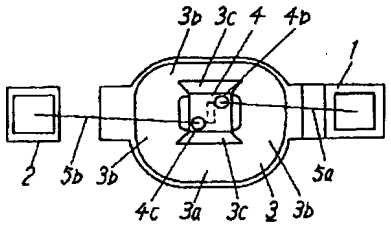
【図１】本発明の一実施の形態による窒化ガリウム系化

合物半導体発光素子を用いた発光装置の要部を示す縦断面図
【図２】図１の平面図
【図３】図１のＡ－Ａ線矢視による縦断面図
【図４】マウントへの発光素子の組込み及び反射光の光路を示す要部の拡大縦断面図
【図５】マウントの反射ブロックの上に発光素子を搭載して組み込む例であって、（ａ）は透明のペーストによって発光素子を接合した要部の縦断面図（ｂ）は透明ガラスの上に発光素子を搭載した要部の縦断面図
【図６】従来のＬＥＤランプを示す概略図
【符号の説明】
１　リードフレーム
２　リードフレーム
３　マウント
３ａ　緩傾斜面
３ｂ　常用反射面
３ｃ　保持座
３ｄ　キャビティ
３ｅ　反射ブロック
３ｆ，３ｇ　受光反射面
４　発光素子
４ａ　結晶基板
４ｂ　ｐ側電極
４ｃ　ｎ側電極
５ａ，５ｂ　ワイヤ
６　ペースト
７　透明ガラス

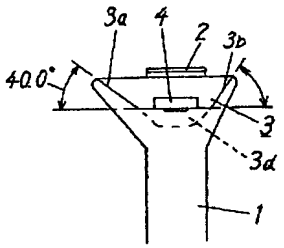
【図１】



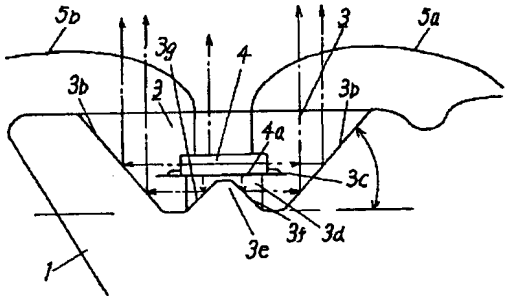
【図２】



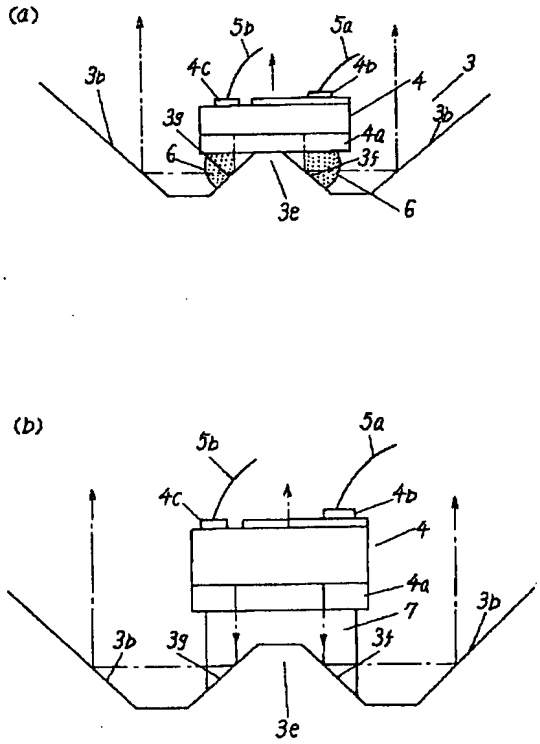
【図３】



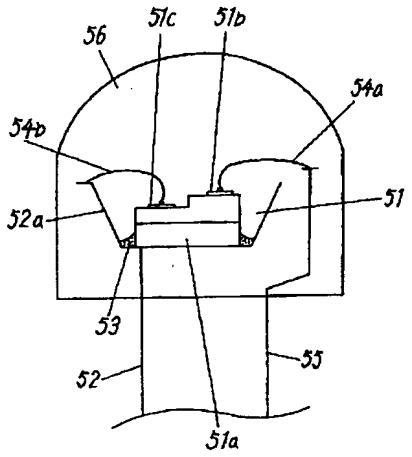
【図４】



【図５】



【図６】



フロントページの続き

(72)発明者　内田　浩
大阪府高槻市幸町１番１号　松下電子工業
株式会社内